Audiovisual Analytics of social linked data

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Abstract: Audiovisual analytics of social data is useful for State and private management, scientific and individual endeavors. If there is data, information or knowledge in a computer, and the observer or user should have it, the employment of visual cues is an obvious, and sometimes considered optimized, strategy because of the efficiency and complexity of our visual cognition. Our auditory cognition is sometimes considered of greater complexity, due to patterns of music and spoken language. How to correctly formalize the mapping of data, information and knowledge to physical stimuli and then to the perceived stimuli respecting the Weber-Fechner and Steven's laws at least for visual and auditory cues? How to correctly express data visualization theory and practice, relating datatypes to processing routines and suitable audiovisualizations? This document, with the bibliographic items, is available at `https://github.com/ttm/aavo/raw/master/latex/nuvem/nuvem2.pdf`.

1. Introduction

Linked data is useful for data integration from different sources, for semantic representation and manipulation of data, such as by automated inferences, and sound conceptual considerations of both domain and context knowledge. The mapping of data to audiovisual cues involves a number of routines, conceptual frameworks, and data. The scaling and integration factors are decisive in settings of big data such as in social data mining. The study of data that expresses human social systems poses ethical and conceptual challenges [1, 2]. An overview of the Linked Open Social Data translated to RDF and related ontologies and vocabularies can be found in [3–5]. Some limitations of current linked data standards are described and potential solutions given in [6].

2. Current Framework

We obtained compelling algebraic, empiric and conceptual analyses of social structures [4, 7], often supported by software, which is a very efficient way to represent what is being performed (although also very incomplete). In this section, we focus on current efforts around Audiovisual Analytics.

2.1. AAVO

AAVO is a first tentative ontology for Audiovisual Analytics. Figure 1 depicts the AAVO Core, and both Core and Extended AAVO are well described in [8]. The following concepts/classes are envisioned for the core but not yet implemented: Hypothesis, Analysis, Task/Purpose/Application. Some relations seem less fundamental then others, which might be expressed using the techniques described in [6]. AAVO is very incipient, and will most probably receive other layers of conceptualizations beyond Core and Extended, such as for data type, colors, charts, etc.

Its purposes are: automated inferences and recommendations on contexts involving data visualization (e.g. for suitable visualizations given a dataset or vice-versa); enable relevant theoretical discussions by having an established and formal conceptualization; provide a representation of data that is friendly for both humans and machines (in browsing, discovery, inference); underpin data integration; provide the conceptual and data architecture for the audiovisual analytics software described in the next section.

2.2. An audiovisual analytics platform for social systems

A software system, a web platform for audiovisual analytics of big data, has been envisioned with the following characteristics:

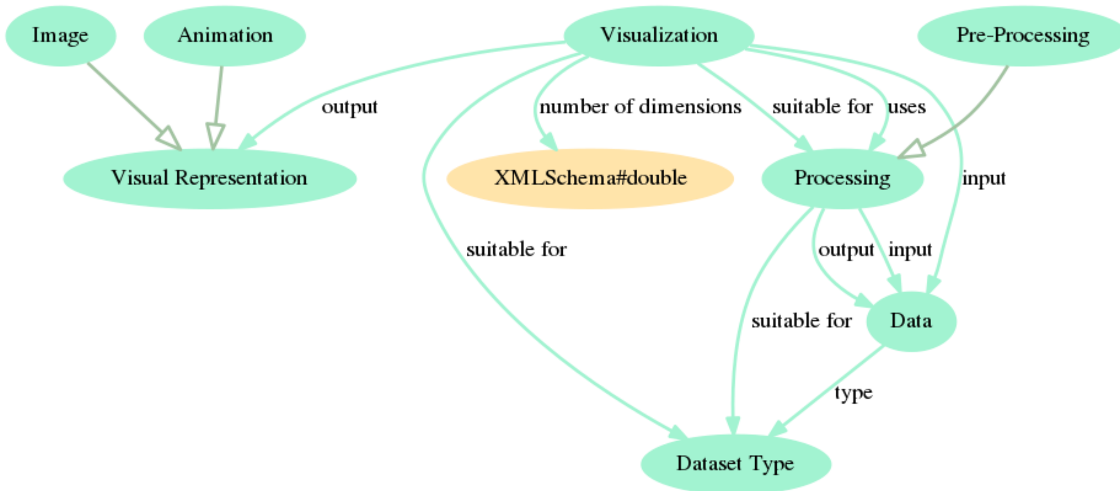

Fig. 1. A graphical representation of current AAVO Core. More information in Section 2.1.

- Interface has capabilities of making automated and periodic changes of the presentation of the content (data and analyses). This entails a fractal and musical consideration of the audiovisualzations. User might pause and set changing patterns.
- The simultaneous use of both the vision and auditory channels. User might mute or focus on the sonic cues.
- The system has the purpose of providing an aesthetic experience to the user. This includes facilities to render audiovisual media for aesthetic appreciation or attractive representation of analyses [9].
- Keeps records of state through users and sessions. Each session has a set of states, each state a set of interface parametrization and data references. Annotations might be linked to users, sessions, states, data, analysis methods, widgets, etc; and categorized by keywords or simple values.
- Persistence (probably through the web browser's sandbox) to allow a user to reload already downloaded software and data, and to allow a user to work offline.
- Sharing of sessions, states, data, and annotations among users, preferably in real time (as achieved through Meteor.js). Sharing of media to non-users and for presenting results.
- A written interface to control the system which should be suitable for scripting, one line commands, keyboard shortcuts. It will probably be JavaScript with Vim-like one-liners and scripting. (The written interface expresses a very broad space of possible commands.)
- Linked data to achieve a formal and browsing-friendly representation of data for both humans and machines; for a unified consideration of both data and knowledge architecture; facilitates the linkage of metadata from users; facilitates resources recommendations.
- Emphasis on the analysis of networks and text (and their simultaneous analysis), reason why it is fit for social networks, but also for general complex networks and textual data.
- Designed to be enhanced with use by means of tests with users, and of analyses of sessions and states (maybe have facilities to record mouse movement, clicks and keyboard strokes).

The temporal dynamic of the interface is useful to make a rapid scan of the data by parts. Observing data by parts is a core procedure in mining big data. Persistence is also valued for the purpose of analyzing big data. Complex networks and text yield a broad user base and set of knowledge fields which might be studied with help of such system. The focus on social structures entails analysis results of interest to scientific research, State and private sectors. Art in current and envisioned developments is useful for favoring an attentive interaction of the user, the enhancement of formal documents and the engagement of layman.

2.3. *Perceptual framework*

Frequency and intensity are related to pitch and volume through the Weber-Fechner law. One might also think about durations on the same sense. Visual stimuli, on the other hand, seem to be more often modeled by the Steven's law (is this true?). Is it possible to relate frequency and intensity to pitch and loudness through Steven's law? Is the perception of visual cues also fit by Weber-Fechner? The Steven's law is a power law while Weber-Fechner is an exponential law:

$$\Delta p = log_X(e_1/e_0) \tag{1}$$

for Weber-Fechner and

$$p = k.e_1^{\alpha} \tag{2}$$

for Steven's, where p is the (subjective) magnitude of the perceived stimuli, X and α depend on the stimuli, and e_0 and k depend on the the units used. Δp is an interval, a distance, in the perceived magnitude. x, α, e_0 and k are usually considered constants.

In equally spaced samples of the stimuli (e.g. in PCM audio), the sample values might express amplitude or frequency. If the sample values represent durations, the separation between samples looses its meaning, but enables a Fourier analysis in a 'virtual' or 'imaginary' space. For example, consider the Fouriter transform of this sequence of durations in seconds: [1, 0.5, 0,5, 1, 0.5, 0.5]. The components are sinusoids whose amplitude is duration. The durations are the sample values, each value corresponding to a sample separated by a virtual (unitary) distance.

Related to sound, most traditional music notation and qualities respect the Weber-Fechner law, with note grids (e.g. semitones, octaves), respecting the logarithm of frequency: interval= $log_2(f_1/f_0)$, loudness= $log_{10}(p_1/p_0)$. Duration seems also to be conceptualized as such because musical notation uses the division in two (simple, imperfectus), amd three (perfectus) yielding a grid having $d_i = d_{i+1}/2$ and $d_i = d_{i+1}/3$. $durations = 2^{x-i}$ and $= 3^{x-i}$. Which implies $log_2(dur) = x - i \Rightarrow i = log_2(X/dur)$, $x = log_2 X$. A Weber-Fechner compliant relation between the number of the durations and depth of the division x-i = (4, 8, 16) for simple, (3, 9, 12) for compound, (5,7,13) complex. 6 is compound in traditional music theory, but is the only one that relates periods of 2 and 3,

The Human Processor Model [10] has somewhat established values for a number of cognitive characteristics such as eye movement time (230ms), half-life of visual image storage (200ms) and of working memory (7s), and visual and auditory capacities (17 letters, 5 letters). These reference values, together with the equations relating physical and perceived stimuli, should be integrated to AAVO.

2.4. *Other: Erdös Sectioning, KS-derived statistics, Wordnet, text mining, stability and differentiation, partnerships*

Other works, such as the classification of participants (vertices) as hubs, intermediary and peripheral; statistical tests e.g. to observe linguistic differences among the network participants; the use of Wordnet and token-oriented methods for text mining; and current partnership with researchers in physics, computer science, mathematics, philosopy and social sciences, clinical and social psychology, give some of the support for our endeavors. [4]

2.5. *What to do?*

We will surely integrate the envisioned concepts into AAVO Core. We should develop the system in Section 2.2 to some extent, maybe for concept proofs or simple prototyping.

With the research groups @Nuvem, especially with those more related to audiovisual and social issues, we might relate the missing concepts in AAVO, or enhance the software design of the system; try to find more about the right tools for visualizing ontologies and social data, or about pertinent analysis methods and known conceptualizations. @Nuvem researchers might want to formalize their own conceptualizations, and concepts related to AAVO might have similar developments or be confluent (e.g. symbiotic) with Section 2: software, theoretical framework, research and institutional experiments and equipment, linked data, and other initiatives or knowledge. Help on correctly describing the mapping of data to physical and cognitive stimuli, as in Section 2.3, will be highly appreciated. We might share and consider other supporting resources of our research, e.g. those in Section 2.4, upon interest.

2.6. *Acknowledgments*

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